OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **PERKINS POND, SUNAPEE,** the program coordinators have made the following observations and recommendations:

Thank you for your continued hard work sampling the pond this season! Your monitoring group sampled **six** times this season! As you know, multiple sampling events each season enable DES to more accurately detect water quality changes. Keep up the good work!

The Perkins Pond Diagnostic Study is progressing as scheduled. Routine field and follow-up sampling work is complete. More than 40 routine sampling rounds targeting flows and chemistry of the tributaries commenced in May, 2005. Gary Szalucka documented stream gage readings for approximately 30 dates during the course of the study period. Follow up field work including stream flow analysis of the Ledge Pond Brook Inlet versus the North Outlet, nonpoint source problem areas, and three rain event sampling events took place in August and September of 2005. Thanks to the efforts of Anne Van Tine a final round of septic system surveys were distributed during the summer of 2005. Field surveys documenting land use have been completed but still need data entry for spatial analysis. Stream flow data entry and analysis began in January, 2006. Draft hydrologic and nutrient budgets are scheduled for review during the summer of 2006.

FIGURE INTERPRETATION

- **Figure 1 and Table 1:** Figure 1 (Appendix A) shows the historical and current year chlorophyll-a concentration in the water column. Table 1 (Appendix B) lists the maximum, minimum, and mean concentration for each sampling season that the pond has been monitored through VLAP.

  Chlorophyll-a, a pigment found in plants, is an indicator of the algal abundance. Because algae are usually microscopic plants that contain chlorophyll-a, and are naturally found in lake ecosystems, the chlorophyll-a concentration measured in the water gives an estimation of the algal concentration or lake productivity. **The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m^3.**

The current year data (the top graph) show that the chlorophyll-a concentration ***increased*** from **May** to **August,** ***decreased*** from **August** to **September,** and then ***increased*** from **September** to **October.**

The historical data (the bottom graph) show that the 2005 chlorophyll-a mean is ***greater than*** the state median and the similar lake median (for more information on the similar lake median, refer to Appendix F).

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual chlorophyll-a concentration has ***not significantly changed*** since monitoring began**.** Specifically, the chlorophyll-a concentration has ***fluctuated between approximately 3.2 and 10.3 mg/m^3,*** has ***not continually increased or decreased*** since **1987.** (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

While algae are naturally present in all ponds, an excessive or increasing amount of any type is not welcomed. In freshwater ponds, phosphorus is the nutrient that algae depend upon for growth. Algal concentrations may increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase (such as sediment phosphorus releases, known as internal loading). Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about activities within the watershed that affect phosphorus loading and pond quality.

- **Figure 2 and Table 3:** Figure 2 (Appendix A) shows the historical and current year data for pond transparency. Table 3 (Appendix B) lists the maximum, minimum and mean transparency data for each sampling season that the pond has been monitored through VLAP.

  Volunteer monitors use the Secchi Disk, a 20 cm disk with alternating black and white quadrants, to measure water clarity (how far a person can see into the water). Transparency, a measure of water clarity, can be affected by the amount of algae and sediment from erosion, as well as the natural colors of the water. **The median summer transparency for New Hampshire's lakes and ponds is 3.2 meters.**

The current year data (the top graph) show that the in-lake transparency ***decreased gradually*** from **May** to **October**. The Secchi Disk was visible on the pond bottom on the **May** sampling event but was not visible on the pond bottom on the rest of the sampling events.

It is important to note that as the chlorophyll concentration ***increased overall*** at the deep spot as the summer progressed, the transparency ***decreased.*** We typically expect this ***inverse*** relationship in lakes. As the amount of algal cells in the water ***increases,*** the depth to which one can see into the water column typically ***decreases***.

The historical data (the bottom graph) show that the 2005 mean transparency is ***less than*** the similar lake median (refer to Appendix F for more information about the similar lake median).

Overall, the statistical analysis of the historical data (the bottom graph) shows that the mean annual transparency has ***not significantly changed*** since monitoring began. Specifically, the transparency has ***fluctuated between approximately 1.9 and 2.9 meters*** has ***not continually increased or decreased*** since **1987**. (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

Typically, high intensity rainfall causes sediment erosion to flow into ponds and streams, thus increasing turbidity and decreasing clarity. Efforts should continually be made to stabilize stream banks, pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the pond. Guides to Best Management Practices designed to reduce, and possibly even eliminate, nonpoint source pollutants, such as sediment loading, are available from DES upon request.

- **Figure 3 and Table 8:** The graphs in Figure 3 (Appendix A) show the amount of epilimnetic (upper layer) phosphorus and hypolimnetic (lower layer) phosphorus; the inset graphs show current year data. Table 8 (Appendix B) lists the annual maximum, minimum, and median concentration for each deep spot layer and each tributary since the pond has joined VLAP.

  Phosphorus is the limiting nutrient for plant and algae growth in New Hampshire's freshwater lakes and ponds. Excessive phosphorus in a pond can lead to increased plant and algal growth over time. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is**

12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.

Overall, the current year data for the epilimnion (the top inset graph) and the hypolimnion (the bottom inset graph) show that the phosphorus concentration ***increased gradually*** from **May** to **August**, and then ***decreased gradually*** from **August** to **October**.

The historical data show that the 2005 mean epilimnetic phosphorus concentration is ***approximately equal to*** the state median and is ***slightly less than*** the similar lake median (refer to Appendix F for more information about the similar lake median).

The turbidity of the hypolimnion (lower layer) sample was ***at least slightly elevated*** on each sampling event this season. The hypolimnetic turbidity has been at least slightly elevated on most sampling events during previous sampling seasons. This suggests that the lake bottom is covered by a thick organic layer of sediment which is easily disturbed. When the pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

The historical data show that the 2005 mean hypolimnetic phosphorus concentration is ***less than*** the state median and the similar lake median (refer to Appendix F for more information about the similar lake median).

Overall, the statistical analysis of the historical data shows that the phosphorus concentration in the epilimnion (upper layer) and the hypolimnion (lower layer) has ***not significantly changed*** since monitoring began. Specifically, the epilimnetic phosphorus concentration has ***fluctuated between approximately 5.5 and 15 ug/L,*** and the hypolimnetic phosphorus concentration has ***fluctuated between approximately 8.0 and 21 ug/L*** since **1987.** (Note: Please refer to Appendix E for the detailed statistical analysis explanation and data print out.)

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about its sources and how excessive amounts can adversely impact the ecology and the recreational, economical, and ecological value of lakes and ponds. Phosphorus sources within a pond's watershed typically include septic systems, animal waste, lawn fertilizer, road and construction erosion, and natural wetlands.

TABLE INTERPRETATION

- **Table 2: Phytoplankton**
  Table 2 (Appendix B) lists the current and historical phytoplankton species observed in the pond. Specifically, this table lists the three most dominant phytoplankton species observed in the sample and their relative abundance in the sample.

  The dominant phytoplankton species observed in the **August** sample were ***Rhizosolenia*** **(diatom),** ***Staurastrum*** **(green),** and ***Synedra*** **(diatom).**

  Phytoplankton populations undergo a natural succession during the growing season (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding seasonal plankton succession). Diatoms and golden-brown algae are typical in New Hampshire's less productive lakes and ponds.

- **Table 2: Cyanobacteria**
  A **small amount** of the cyanobacterium ***Microcystis*** was observed in the plankton sample this season. ***This species, if present in large amounts, can be toxic to livestock, wildlife, pets, and humans.*** (Please refer to the "Biological Monitoring Parameters" section of this report for a more detailed explanation regarding cyanobacteria).

  Cyanobacteria can reach nuisance levels when phosphorus loading from the watershed to surface waters is increased (this is often caused by rain events) and favorable environmental conditions occur (such as a period of sunny, warm weather).

  The presence of cyanobacteria serves as a reminder of the pond's delicate balance. Watershed residents should continue to act proactively to reduce nutrient loading to the pond by eliminating fertilizer use on lawns, keeping the pond shoreline natural, re-vegetating cleared areas within the watershed, and properly maintaining septic systems and roads.

  In addition, residents should also observe the pond in September and October during the time of fall turnover (lake mixing) to document any algal blooms that may occur. Cyanobacteria have the ability to regulate their depth in the water column by producing or releasing gas from vesicles. However, occasionally lake mixing can affect their buoyancy and cause them to rise to the surface and bloom. Wind and currents tend to "pile" cyanobacteria into scums that accumulate in one section of the pond. If a fall bloom occurs, please collect a sample (any clean jar or bottle will be suitable) and contact the VLAP Coordinator.

- **Table 4: pH**
  Table 4 (Appendix B) presents the in-lake and tributary current year and historical pH data.

  pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the surface waters in the state are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean pH at the deep spot this season ranged from **6.77** in the hypolimnion to **6.67** in the epilimnion, which means that the water is ***slightly acidic.***

  Due to the presence of granite bedrock in the state and acid deposition (from snowmelt, rainfall, and atmospheric particulates) in New Hampshire, there is not much that can be done to effectively increase pond pH.

- **Table 5: Acid Neutralizing Capacity**
  Table 5 (Appendix B) presents the current year and historical epilimnetic ANC for each year the pond has been monitored through VLAP.

  Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.9 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

  The mean Acid Neutralizing Capacity (ANC) of the epilimnion (the upper layer) was **6.8 mg/L** this season, which is ***greater than*** the state median. In addition, this indicates that the pond is ***moderately vulnerable*** to acidic inputs (such as acid precipitation).

- **Table 6: Conductivity**
  Table 6 (Appendix B) presents the current and historical conductivity values for tributaries and in-lake data. Conductivity is the numerical expression of the ability of water to carry an electric current (which is determined by the number of negatively charged ions from metals,

salts, and minerals in the water column). The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The mean annual conductivity in the epilimnion at the deep spot this season was **62.08 uMhos/cm**, which is ***greater than*** the state median.

The conductivity has ***increased*** at the **deep spot** of the pond, the **inlets**, and the **outlet** since monitoring began. Typically, sources of increased conductivity are due to human activity. These activities include failed or marginally functioning septic systems, agricultural runoff, and road runoff (which contains road salt during the spring snow melt). New development in the watershed can alter runoff patterns and expose new soil and bedrock areas, which could contribute to increasing conductivity. In addition, natural sources, such as iron and manganese deposits in bedrock, can influence conductivity.

We also recommend that your monitoring group conduct a shoreline conductivity survey of the lake and the tributaries with ***elevated*** conductivity to help pinpoint the sources of ***elevated*** conductivity.

To learn how to conduct a shoreline or tributary conductivity survey, please refer to the 2004 "Special Topic Article" or contact the VLAP Coordinator.

- **Table 8: Total Phosphorus**

Table 8 (Appendix B) presents the current year and historical total phosphorus data for in-lake and tributary stations. Phosphorus is the nutrient that limits the algae's ability to grow and reproduce. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The total phosphorus concentration was ***elevated*** (**33 ug/L**) in **the Outlet** sample on the **August** sampling event. The turbidity (Table 11) of the sample was also ***elevated*** (**2.08 NTUs**) on the **August** sampling event. The turbidity in the **Outlet** sample was also ***elevated*** on the **July** sampling event (**5.04 NTUs**). These data suggest that that the stream bottom may have been disturbed while sampling, that erosion is occurring in this portion of the watershed, and/or that there was a high concentration of algal cells in the samples.

- **Table 9 and Table 10: Dissolved Oxygen and Temperature Data**
  Table 9 (Appendix B) shows the dissolved oxygen/temperature profile(s) for the 2005 sampling season. Table 10 (Appendix B) shows the historical and current year dissolved oxygen concentration in the hypolimnion (lower layer). The presence of dissolved oxygen is vital to fish and amphibians in the water column and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  The dissolved oxygen concentration was ***high*** at all deep spot depths sampled at the pond on the **August** sampling event. Typically, shallow lakes and ponds that are not deep enough to stratify into more than one or two thermal layers will have relatively high amounts of oxygen at all depths. This is due to continual lake mixing and diffusion of oxygen into the bottom waters induced by wind and wave action.

- **Table 11: Turbidity**
  Table 11 (Appendix B) lists the current year and historical data for in-lake and tributary turbidity. Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the "Other Monitoring Parameters" section of this report for a more detailed explanation.

  The epilimnetic turbidity was ***elevated*** on the **August, September,** and **October** sampling events (**1.8 to 2.9 NTUs**), possibly due to a high concentration of algal cells in the water column.

  As discussed previously, the hypolimnetic turbidity was ***at least slightly elevated*** on each sampling event this season and on most sampling events during previous sampling seasons. This suggests that that the lake bottom is covered by a thick organic layer of sediment which is easily disturbed. When the pond bottom is disturbed, sediment, which typically contains attached phosphorus, is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

  The turbidity in the **outlet** sample was ***at least slightly elevated*** on each sampling event this season. This station has had a history of slightly elevated and fluctuating turbidity levels which suggests that erosion is occurring in this area of the watershed and/or a high concentration of algal cells contribute to the turbidity in this location.

- **Table 12: Bacteria (*E.coli*)**

  Table 12 lists the current year and historical data for bacteria *(E.coli*) testing. (Please note that Table 12 now lists the maximum and minimum results for this season and for all past sampling seasons.) *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is easily cultured and its presence in the water, in defined amounts, indicates that sewage **MAY** be present. If sewage is present in the water, potentially harmful disease-causing organisms **MAY** also be present.

  The *E. coli* concentration at **Piney Point Rd Lot 26** was ***elevated*** on the **August** sampling event. However, the concentration of **270** counts per 100 mL ***was not greater than*** the state standard of 406 counts per 100 mL for recreational waters that are not designated public beaches.

  If you are concerned about *E. coli* levels at this station, your monitoring group should conduct rain event sampling and bracket sampling in this area. This additional sampling may help us determine the source of the bacteria.

  For a detailed explanation on how to conduct rain event and bracketing sampling, please refer to the 2002 VLAP Annual Report "Special Topic Article" or contact the VLAP Coordinator.

- **Table 13: Chloride**

  The chloride ion (Cl^-) is found naturally in some surfacewaters and groundwaters and in high concentrations in seawater. Research has shown that ***elevated*** chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

  Chloride sampling was not conducted in **2005**.

  A limited amount of chloride sampling was conducted in **2003**. The epilimnetic result was **11 mg/L**, which is ***less than*** the state acute and chronic chloride criteria. However, this concentration is ***greater than*** what we would normally expect to measure in undisturbed New Hampshire surface waters.

We recommend that your monitoring group conduct chloride sampling in the epilimnion at the deep spot and in the inlets near salted-roadways, particularly in the spring, soon after snow-melt and after rain events during the summer. This will establish a baseline of data that will assist your monitoring group and DES to determine lake quality trends in the future.

Please note that there will be an additional cost for each of the chloride samples and that these samples must be analyzed at the DES laboratory in Concord. In addition, it is best to conduct chloride sampling in the spring as the snow is melting and during rain events.

- **Table 14: Current Year Biological and Chemical Raw Data**
  This table lists the most current sampling season results. Since the maximum, minimum, and annual mean values for each parameter are not shown on this table, this table displays the current year "raw" (meaning unprocessed) data. The results are sorted by station, depth zone (epilimnion, metalimnion, and hypolimnion) and parameter.

- **Table 15: Station Table**
  As of the Spring of 2004, all historical and current year VLAP data are included in the DES Environmental Monitoring Database (EMD). To facilitate the transfer of VLAP data into the EMD, a new station identification system had to be developed. While volunteer monitoring groups can still use the sampling station names that they have used in the past (and are most familiar with), an EMD station name also exists for each VLAP sampling location. For each station sampled at your pond, Table 15 identifies what EMD station name corresponds to the station names you have used in the past and will continue to use in the future.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit:

During the annual visit to your pond, the biologist conducted a "Sampling Procedures Assessment Audit" for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled out an assessment audit sheet to document the ability of the volunteer monitors to follow the proper field sampling procedures (as outlined in the VLAP Monitor's Field Manual). This assessment is used to identify any aspects of sample collection in which volunteer monitors fail to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples that the volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an ***excellent*** job collecting samples on the annual biologist visit this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist:

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if the volunteer monitors followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, future re-occurrences of improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an ***excellent*** job when collecting samples and submitting them to the laboratory this season! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, NHDES Fact Sheet ARD-32, (603) 271-2975 or www.des.state.nh.us/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES Booklet WD-03-42, (603) 271-2975.

Best Management Practices for Well Drilling Operations, NHDES Fact Sheet WD-WSEB-21-4, (603) 271-2975 or www.des.nh.gov/factsheets/ws/ws-21-4.htm.

Canada Geese Facts and Management Options, NHDES Fact Sheet BB-53, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-53.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, NHDES Fact Sheet WMB-10, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, NHDES Fact Sheet WD-SP-1, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-1.htm.

Impacts of Development Upon Stormwater Runoff, NHDES Fact Sheet WD-WQE-7, (603) 271-2975 or www.des.state.nh.us/factsheets/wqe/wqe-7.htm.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, NHDES Fact Sheet WD-BB-9, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-9.htm.

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters NHDES Fact Sheet WD-WMB-16, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-17.htm.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, NHDES Fact Sheet WD-SP-2, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, NHDES Fact Sheet WD-WMB-4, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, NHDES Fact Sheet WD-BB-15, (603) 271-2975 or www.des.state.nh.us/factsheets/bb/bb-15.htm.

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act, NHDES Fact Sheet SP-4, (603) 271-2975 or www.des.state.nh.us/factsheets/sp/sp-4.htm.

Soil Erosion and Sediment Control on Construction Sites, NHDES Fact Sheet WQE-6, (603) 271-2975 or www.des.state.nh.us/factsheets/wqe/wqe-6.htm.

Through the Looking Glass: A Field Guide to Aquatic Plants, North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

Watershed Districts and Ordinances, NHDES Fact Sheet WD-WMB-16, (603) 271-2975 or www.des.state.nh.us/factsheets/wmb/wmb-16.htm.